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THE OILFIELDS OF NORTH-WEST INDIA*

By E. S. PINFOLD, M.A., F.G.S.

Four oilfields have so far been brought into production in the north-west corner of the Punjab only a short distance from the border of the North-West Frontier Province. The fields are worked by the Attock Oil Company with headquarters in the pleasant military station of Rawalpindi. The refinery is three miles south-east of this town, the oil being brought from the fields, some forty to fifty miles away to the south-west, by pipeline and rail transport.

The oilfields are situated in the region known as the Potwar, a rolling plateau at 1300 to 1700 feet above sea level, deeply dissected by gorges cut through the soft loess and Tertiary deposits by the Soan River and its numerous tributaries. The plateau is bounded on the south and west by the precipitous scarps of the Salt Range and to the north by the outer foothills of the Himalaya.

For six months in the year the climate is all that could be desired, with occasional night frosts and a maximum day temperature around 80°F. In April, May, and September, temperatures may run high dependent upon rainfall and dust storms. From June to the end of August the weather is very hot and the thermometer occasionally reaches 118°F or more, but the hot weather is tempered to some extent by rains, more especially in July and August. Gardening is a favourite hobby; evening football and and hockey in the hot weather, daytime cricket in the winter, a good golf

* Address to the Students' Section (London Branch), March 20, 1947.

course, and the usual club life, help to make the north-west Punjab a pleasant place in which to spend part of one's life and labours. A certain amount of local leave is granted to everybody and this is taken usually in the hot weather. The hill station of Murree, with an elevation of over 7000 feet, is only forty miles from Rawalpindi along a good motor road and is a favourite summer resort. The vale of Kashmir with its many attractions for holiday makers—houseboat life, trekking, fishing, shooting, golf, etc—is 160 miles further along the same excellent motor road, cut for the most part in the banks of the Jhelum River.

Geological Features

Geologically, the oil belt of north-west India may be regarded as forming an eastern continuation of the chain of oilfields which are associated with the outer foothills of the Tertiary and post-Tertiary Alpine Ranges. The oil occurs and is believed to have originated in marine or brackish water Eocene beds, now overlain by many thousands of feet of riverine deposits of Upper Tertiary age. The source-rocks represent the last phases of the Tethys sea near the southern margin of the Himalayan geosyncline.

Well at Dhulian

Deposits of Cambrian, Permo-Carboniferous, Triassic, Jurassic, Cretaceous, and Eocene ages are well exposed in the scarps and glens of the Salt Range and in the northern hills. They are mostly of shallow-water marine origin and, although considerable unconformities are indicated by the gaps in the stratigraphic succession, there is little discordance and no evidence of severe folding during these periods. The alternation of marine, lagoon, and fresh-water conditions which occurred towards the end of Eocene times may be witness to the commencement of the earth-movements which resulted eventually in the formation of the Himalayan ranges. The Eocene is followed by a major unconformity and the Oligocene is absent. The succeeding deposits are sandstones, shales, and conglomerates of great thickness—the Murree-Siwalik or Nimadric System—laid down by the rivers which drained the mountains forming to the north. Most of the earth-movement which affected the oil-belt occurred in late Pliocene and Pleistocene times, the Upper Tertiary deposits being folded and faulted to much the same extent as the earlier formations. During these earth-movements the region underwent severe compression and the existing structural complications indicate that the ancient shield of peninsular India must have moved northwards relatively towards the Tibetan plateau, squeezing the intervening geosynclinal tract of mainly Tertiary deposits. The total relative horizontal movement indicated is of the order of 150 to 200 miles.

As may be expected under these conditions, the geological structure is extremely complicated in the north and becomes progressively simpler and more open to the south. In the Salt Range

the structure appears to be determined mainly by block faulting with subsidiary overturning. The Salt Range Scarp looks southwards over the plains of the Indus-Jhelum alluvium which intervene between the Potwar and the nearest outcrops of Archaen rocks in outliers to the south.

The Oilfields of N.W. India

The Oilfields

The four oilfields so far discovered lie in the central and southern parts of the plateau. All of them are situated at the crests of simple and robust anticlinals. Test wells in the more complicated structures of the northern foothills as also two tests drilled many years ago towards the southern edge of the plateau, have given only negative or inconclusive results.

The major part of the oil production obtained to date has been from the Eocene, and there is much to suggest that the oil originated at about the same horizon in beds which were laid down during the change from open sea to inland sea and fresh-water conditions. The oil-bearing beds are porcellanous dolomites and more massive fossiliferous limestones associated with shales and anhydrite. The rock salt of the Kohat District occurs in these beds but no Tertiary rock salt has been found in the borings. A deep test well at Joya Mair has been carried down through the Carboniferous Lavender Clays into the Purple Sandstones of the Cambrian and the salt marls of the Punjab Saline Series. A small show of oil occurred in the Purple Sandstone and thick beds of rock salt in the Punjab Saline Series, which is probably of Cambrian or pre-Cambrian age, though this has been the subject of much controversy.

In the Khaur oilfield a large part of the oil was obtained from the Upper Tertiary sandstones which overlie the Eocene; this oil is believed to have obtained this position by upward migration. At Dhulian only a small production of "black" oil has been obtained from these upper beds and almost all production from that field has been from the Eocene. At Joya Mair and Balkassar only the Eocene limestones have so far proved productive.

An article describing the history of prospecting and development in northwest India has recently been published (*Petrol. Times*, 1.2.47, **51**, 119) and this includes a geological map of the region showing the position of the oilfields. The search for oil commenced about 1860 to 1870 when A. W. Wynne of the Geological Survey of India mapped the Potwar and Salt Range in considerable detail and described many of the numerous surface seepages. The Punjab Government participated in the drilling of several test wells between 1860 and 1890 and a small yield of oil was obtained. The first company to use more up-to-date equipment was

A Kashmir Valley

The Indolex Oil Syndicate: this company drilled two moderately deep wells at Golra north of Rawalpindi in 1913 but both were unsuccessful. The Attock Oil Co. commenced work in 1913 and oil in commercial quantities was struck early in 1915 at shallow depths at Khaur. Production has since been obtained from several sands in this field between 150 and over 5000 feet, the lowest oil found being in Eocene limestone.

Due to wartime conditions the refinery at Rawalpindi was not completed until 1922. Despite encouraging results in the earlier stages, production at Khaur fell away rapidly and, with a total production to date of four million barrels, this field is now almost exhausted and yields only a small production from a large number of pumping wells. Khaur is 40 miles west-south-west of Rawalpindi.

The Dhulian field, ten miles farther to the west-south-west, was discovered in 1937. At this field the oil horizon is at a depth of over 7500 feet. The oil and accompanying water are under high reservoir pressure and all wells flow naturally. This field has produced over five million barrels to date, but is now well past its peak and production from it is declining.

The Joya Mair and Balkassar fields are recent discoveries still in the early stages of development. Joya Mair is 25 miles south-east of Khaur, and Balkassar is the same distance south-east of Dhulian. In these southern fields the oil occurs near the top of the Eocene limestone at depths of 7000 and 8200 feet respectively. It is remarkable that, although the oil from the older fields is a good quality light crude containing only small percentages of asphalt and wax, the oil from Joya Mair is highly asphaltic and consists of a mixture of hard asphalt with kerosine and petrol, the intermediate diesel and lubricating oil fractions being absent. The Balkassar crude contains somewhat less asphalt but is still inferior to the crude from the older fields.

Many interesting problems connected with the oilfields and their development still await solution; amongst them are: the construction of sections at depth from the surface evidence; the cause of the variation in the character of the crude oils from different fields; the variable salinity of the waters associated with the oil; the high reservoir pressures and the variation in reservoir pressure from one field to another and at different horizons in a single field.

The main problem is, however, the provision of new supplies, more especially of the higher grade oils similar to those of the two northern fields. Active prospecting continues, and both the Attock Oil Company and the Burmah Oil Company have test wells in hand or in course of preparation at the present time.

COLLOIDAL CHEMISTRY OF DRILLING MUDS

Part I—FUNCTIONS OF MUD

By A. H. NISSAN, D.Sc., F.Inst.Pet.

This is the first of two articles which outline the functions of drilling mud and the scientific principles which govern its control. Dr Nissan has written these articles in recognition of the great importance which correct control of drilling mud now assumes in oil-well drilling.

We hope that they will evoke contributions by mud engineers, production engineers, and drilling executives offering practical information and suggestions covering actual experience concerning this very important subject.

It has been stated on a great many occasions that the percussion, or cable-tool system is an obsolescent and indeed dying system, but it is probably true to say that over 35 per cent of the wells drilled in the United States in recent years were by this system. Nevertheless, the rotary drilling method is by far the more popular method and for very deep drilling it is inevitably the chosen method.

The drilling mud circuit is as follows: The mud is sucked from a mud pit by means of duplex pumps. The pumps are usually capable of pumping some 500 to 600 gallons of fluid per minute against a pressure of 500 to 600 p.s.i., and using up to 300 h.p. or more. They are often duplicated as it is of great importance to maintain an adequate supply of mud in emergencies. The mud stream is forced out at the top of the bit in powerful jets, which, reversing their direction of motion, travel upwards in the annulus and out of the well mouth. The mud stream is led via ditches, over shaking screens and through settling and treating pits, arranged round the rig, back to the mud pit.

During the war, a "reverse circulation" method was adopted in many wells for the mud system. In this scheme the mud is pumped into the annulus and out of the drillpipe. Only minor alterations in surface and sub-surface equipment are necessary.

Whilst the mud functions in the same way in both systems, there are certain differences in the absolute value of the properties of the mud required. For example, with the reverse circulation system, lower viscosities are required for the same lifting capacities at equal throughput of mud, as higher speeds are reached than in the normal system.

It has been stated that "down to 5000 feet the drilling of a well is a mechanical problem, whereas below that depth it becomes a drilling mud problem". This situation has led to research into mud properties, and much information is now available on this very complex fluid system. Field mud laboratories as well as base laboratories are made available so that urgent problems met in the drilling of any particular well may be solved quickly. Of course, much has yet to be learned, and indeed, certain mud problems of stability, temperature effects, heaving shale, etc., are as yet unsolved.

Providing Hydrostatic Pressure

In drilling through sub-surface formations there are many special demands made on drilling muds. A wide range of pressures, and waters of different compositions, are met. The sands may be under low pressures or under a pressure head equal to the hydrostatic head exerted by a column of water extending in vertical height from the

water table level in the outcrop of the formation to the depth at which the sand is encountered. Occasionally even higher pressures may be encountered. Similarly gas sand, and the oil sand itself under normal or excessive pressures, may be encountered. All these fluids must be prevented from flowing into the well except when required, and at controlled rates and under safe conditions. Thus a pressure must be exerted at the sand face equal to, or slightly in excess of, the pressure encountered. This counter-pressure may be provided by the mud fluid.

The pressure a column of fluid exerts at a depth of H feet is simply given by

$$P = \frac{Hw}{144}$$

where P = pressure in p.s.i.;
H = head in feet;
w = specific weight of fluid in lb/cu. ft.

Thus, by varying w, the specific weight of the drilling mud, a pressure can be generated due to the column of mud in the well which would exceed the pressure encountered in the formation and hence confine the fluid to its original place whilst drilling and completing the well. Again the value of w may be very simply calculated from the density of the clay or other solid components, and the quantities of solids added to a gallon of water.

Charts have been obtained giving the specific weight for any mud from a knowledge of the weight in pounds of clay added to a gallon of water or *vice versa* the necessary amounts of clay in pounds to be added to a gallon of water to yield any desired specific weight. Similarly the loss in specific weight of a mud due to mixing of mud with fresh water may be calculated or read off charts.

The problem is, however, not purely a matter of density adjustments, even though the standard practice to obtain very high hydrostatic counter-pressures is by adding to the mud heavy components like barytes or (sometimes) galena, and similar heavy minerals. However, the problem of increasing the specific weight of the mud depends largely on colloidal chemistry considerations. Thus, adding minerals to the water alters the viscosity; for satisfactory suspension of these heavy materials the mud must be stable; if "weighting" agents are added and the viscosity is increased, gas finding its way into the mud may be unable to leave the mud in the ditches and will, therefore, produce a low density mud—a so-called "gas-cut" mud—which may be lighter than the original mud, thus leading to the hazards of a blow-out. Thus not only is a density problem, such as the provision of a hydrostatic head, dependent on other properties of the colloidal system, but also practically all the other properties are inter-dependent.

Sealing Off Low-Pressure Sands

The dangers associated with high-pressure seal are blow-outs, and with low-pressure sands drilling fluids may be lost into the sands. The mud fluid must provide enough counter-pressure to keep fluids in high-pressure sands in their beds, but if losses are to be avoided it should also build a sheath across low-pressure sand faces which is impervious to the flow of water from the mud into the sand. Further excessive penetration of a low-pressure oil or gas sand by mud may prevent its later exploitation as it may be missed or its flow characteristics spoilt by mud absorption. Such tapping of sealed-off low-pressure oil sands was necessary in the late war, when the demand for oil increased, owing to the difficulties in drilling new wells.

In meeting such low-pressure sands the mud flows into them at first. Some of the fine solids in suspension are first filtered out on the sand face, and prevent still smaller particles from entering the sand. A mud cake is gradually built up until the finest material is deposited, presenting an impervious layer even to the water phase of the mud. In doing so

the diameter of the well is decreased by twice the thickness of the cake. In field parlance this is called "mud ringing". A good mud will build a thin layer of cake impermeable to water even under the high pressure differential. A bad mud will build a thick layer. The "good" mud will differ from the "bad" fundamentally in possessing a preponderance of very fine deflocculated gel—forming clay particles over the coarse flocculated non-gelling clay or sand particles. Occasionally the mud is improved by incorporation of fairly large fibrous or platy solid particles, e.g., mica, gel-flake, etc., but much can be done by properly understanding and controlling the colloidal components of the mud.

Preventing the Disintegration of the Wall of the Well

In drilling through certain types of shales, there is a tendency for the shales on coming in contact with the water in the well to absorb large quantities of water, swell to very much larger volumes than they occupied before, with accompanying high values of pressure generated, and thus "heave" or "slough" into the well. This chemisorption of water followed by heaving is an extremely troublesome phenomenon when encountered in drilling and sometimes very difficult to control. However, the milder forms may be treated successfully by building an impervious cake on the wall through which no water can pass into the formation.

Non-swelling loosely running sands may tend to cave in and flow into the well. A good plastering mud will cope with such a situation by plastering the walls and even imparting a certain amount of rigidity to them.

To Lubricate the Drilling String and Bit

The horsepower imparted to the turntable of a rotary drilling rig may vary from a few units to a few hundred. Of this the friction in the swivel and the rotary table accounts for a small fraction; the major amount going into the friction of the drill-pipe and the wall and into the bits. The friction of the drill-pipe is reduced by means of rubber protectors. Nevertheless, practically all the horsepower of drilling has ultimately to be absorbed by the mud fluid. The life of the bit would be extremely short and bit-cost extremely high unless proper lubrication and cooling were provided.

To Remove the Cutting From the Well

When a piece of rock is chipped or cut by the bit the high velocity jets issuing from the holes in the bit may catch it and lift it. When it reaches the wider annulus between the drill-collar or the drill-pipe and the wall the speed of the mud decreases. The piece of rock will then either continue to ascend with the fluid or descend back to be broken up, depending on the ratio of its weight to the force which the mud is exerting on its surface by virtue of the velocity and viscosity of the mud. The lifting force of the fluid depends on the properties, and velocity of the mud, and on the size and shape of the cutting. In general, however, the higher the rate of flow of the mud and the higher its viscosity, the larger the cutting it will be able to lift to the surface. There is naturally an economic limit to the extent to which both the velocity and the viscosity of the mud can be raised. Further, a very high viscosity may induce "gas-cutting". There are, however, certain optimum values of velocity and viscosity for the mud so that cuttings are brought up to the surface as quickly as possible after being formed and in as large sizes as possible.

Suspending the Cuttings During Shut Down Times

After drilling for some time the mud fluid will be laden with cuttings throughout the depth of the well. On stopping drilling operation and the flow of the

mud, the individual cuttings would tend to settle at rates of fall which depend on its size and shape, and also on the properties of the mud. For cuttings of the same density the rate of fall will increase with the size of the cutting and will decrease as the density and viscosity of the mud increase. Thus, if the cuttings are allowed to settle they would build a bridge between the drill-stem and the well face and prevent further drilling operations. It is the function of a drilling mud to prevent this taking place.

As the density of the mud cannot be widely varied, the viscosity of the mud must be made very high. However, a very viscous mud would be costly to pump and dangerous in gas-cutting areas. A mud is therefore required with a high viscosity when stationary and relatively free to move when under shear. Such kinds of fluids are known as non-Newtonian systems. Newtonian fluids possess a constant viscosity. A true plastic will behave as a solid up to the "yield value" of the stress—i.e., up to the yield value it will deform under stress but on removal of the stress it will recover all its deformation. Above the yield value it will flow. Systems which have high viscosities at zero shear—but, nevertheless, will flow at the smallest stress and which possess low viscosities at high rates of shear—are pseudo-plastic. It is seen then that a mud fluid, to perform the function of suspending the cuttings when no drilling or circulation is taking place and yet possess low viscosity values to be easily pumped and to release gas bubbles readily, will have to be either a plastic or a pseudo-plastic in its behaviour.

There are a number of other duties a drilling fluid may be called upon to perform, but the above are the main demands usually made upon it. It is probably already apparent that some peculiar properties are involved in fulfilling these demands and that these properties are very closely associated with the colloidal nature of the mud. Therefore, in the next article certain general studies and observations on colloidal systems will be made.

Reference

1. Pirson, S. J. *Oil Weekly*, 10.2.41, **100** (10), 21; 17.2.41, **100** (11), 20.

MEXICAN OIL PRODUCTION

Crude oil production in Mexico by the Government and by private companies is reported* as follows:

	Government	*Private*	*Total*
	1000 *barrels*		
1939 ..	41,213	1,685	42,898
1940 ..	42,516	1,520	44,036
1941 ..	41,477	1,577	43,054
1942 ..	33,268	1,547	34,815
1943 ..	34,189	974	35,163
1944 ..	37,004	1,199	38,203
1945 ..	42,153	1,394	43,547
1946† ..	43,456	1,360	44,816

* *Intern. Petrol. Trade*, 1947, **16**, 139; *Bol. de Minas y Petrol*, October 1939–June 1941, pp. 273–6; *Mem. Secretaria Econ. Nac.*, September, 1945–August 1946, p. 264.
† Preliminary.

CHEMISTRY OF OILS, FATS AND WAXES

Courses of lectures in the Modern Chemistry of Oils, Fats and Waxes are to be held at the Chelsea Polytechnic, Manresa Road, Fulham, London, S.W.3. Both courses consist of eight lectures at 7.30 p.m. on Friday evenings, the fee for each course being 10*s*. The first course (Oct. 24 to Dec. 12, 1947, inclusive) will deal with oils and fats, the lecturer being Dr J. H. Skellon. The lectures in waxes by Dr L. Ivanovszky, will start on Jan. 16, 1948, and continue until March 12. Application forms for enrolment are obtainable from the Principal of the Polytechnic.

COAL, PETROLEUM AND THEIR NEWER DERIVATIVES

By FRANK MORTON, Ph.D., M.Sc., F.R.I.C., F.Inst.Pet.

THE Royal Institute of Chemistry Symposium on Coal, Petroleum, and their Newer Derivatives, held at St. Andrews from July 7 to 11, was attended by some 300 members.

The symposium was organized in three parts. The first, under the Chairmanship of Mr C. Augustus Carlow, dealt with Coal and Oil Resources, and included papers by Major Kenneth Gordon, Dr D. T. A. Townend, and Dr C. C. Hall on coal hydrogenation, coal gasification and Fischer-Tropsch synthesis, by Professor W. M. Cumming on hydrocarbons isolated from coal and shale oil, by Dr G. Egloff on recent developments of the Fischer-Tropsch process in the U.S.A., and by Mr A. E. MacColl on the development of hydro-electric power in the Highlands.

The second part, under the Chairmanship of Professor John Read, dealt with Chemical Synthesis. Professor Astbury, Dr R. Hill and Dr J. C. Swallow dealt with synthetic fibres, nylon and polythene, whilst Mr J. M. Brown and Dr E. R. H. Jones dealt with the chemistry of unsaturated compounds.

The third part, under the Chairmanship of Professor N. F. K. Wynne-Jones, dealt with physico-chemical problems of polymerization. Professor M. G. Evans dealt with polymerization, Professor Per-Olof Kinnel with molecular weight determination, and Professor J. N. Brönsted dealt with the energetics of hydrocarbon systems.

The discussion on all these papers was lively and interesting, and the final discussion on July 11 ranged over various aspects of the symposium.

Ample time was provided for the members to enjoy the attractions of St. Andrews and the Fife coast, and short tours of the historic city under the guidance of members of St. Andrews University staff were followed by a brief historical account of St. Andrews by Professor John Read. Informal discussion, over coffees in the House of the Admirable Crichton or over meals in the Halls of Residence, added considerably to the success of the symposium.

The object of the symposium was to present a survey of developments that have taken place in recent years in the

Some of the Conference members outside the Conference Hall

organic chemical industry and this was amply fulfilled, as abstracts of the papers published elsewhere will show. However, the papers in the first section particularly had an important bearing upon one of the major problems of British post-war economics—the efficient utilization of the country's coal and oil resources. Both Major Gordon and Dr Townend stressed the cost factors in the problems they were discussing, and it is apparent that a considerable reduction in the cost of raw material will be necessary before coal hydrogenation can be regarded as a satisfactory process for the production of liquid fuels.

Members of St. Andrews' Conference on their way to a session

The chemist is frequently over-enthusiastic concerning the multitude of products that can be produced from hydrocarbon sources, such as petroleum and coal, and inclined at times to forget that the major importance of these materials for many years to come will be in their use as fuels. Mr C. Augustus Carlow pointed out in his opening remarks that it should be the aim of British scientists to develop products from coal, Britain's major natural source of hydrocarbons, by processes which apart from a brief pilot plant period of tariff protection would be able to compete with imported products and ultimately be exported in quantity. This aspect of the problem was also dealt with by Professor Cumming who stressed the importance of coal as a raw material in synthetic process. It seems unlikely, however, that coal can compete economically with petroleum as a source of aliphatic chemicals and in view of the important contribution to world petroleum resources made by British capital and British scientists, the stress laid upon coal as our major source of material for a future aliphatic chemical industry seems somewhat misplaced. Whilst it is agreed that all measures which can increase the profitability per ton of coal should be taken, it is not desirable to waste time and effort upon developments for which superior alternative raw materials are available within the British Empire.

In the U.S.A., as Dr Egloff pointed out, the availability of natural gas reduces the cost of synthesis gas to a point where operation of the Fischer-Tropsch process, using fluid catalyst technique, can be considered as a future source of liquid fuels. Even here it is questionable whether the process is justified in view of the established market for natural gas, and it is evident from Dr Egloff's account that the process will be developed largely for the synthesis of oxygenated products rather than as an alternative source of hydrocarbon fuels.

In the section dealing with chemical synthesis, the papers were reviews of progress in fields of considerable interest to all chemists. Dr E. R. H. Jones reviewed recent advances in the chemistry of acetylene derivatives and dealt briefly with the production of acetylene whilst Mr J. H. Brown discussed various methods of synthesis of vinyl compounds. Dr R. Hill presented a remarkable picture of the growth of the synthetic fibre industry, and dealt in some detail with the various problems involved in the commercial synthesis of fibre forming macromolecules. Dr J. C. Swallow dealt with the development of polythene, and with the difficulties encountered during the early pilot plant work as well as with the methods by which the qualities of the finished

product could be varied. The series of papers on synthetic fibres, commencing with Professor W. T. Astbury's paper on "The Evolution and Physical Interpretation of Synthetic Fibres", and finishing with Dr J. C. Swallow's paper on "Polythene", formed a most interesting and comprehensive review of this field and it is to be hoped that full publication of these papers will be possible.

In the third section dealing with physico-chemical problems of polymerization, Professor M. G. Evans dealt with recent work on polymerization mechanisms, particularly with determination of rates of initiation, propagation and termination of free radical chain mechanisms. Professor Per-Olof Kinnel gave an account of the methods employed in determining molecular weights of high polymers, and in particular of the ultra-centrifuge methods developed at Upsala. Professor J. N. Brönsted's paper on "The Energetic Properties of Hydrocarbon Mixtures" dealt with deviations from ideality of mixtures of normal paraffins and more particularly with two component systems in which one component—*n*-hexane—was volatile, and the other—a C_{16} or higher paraffin—was solid at ordinary temperatures.

PERSONAL NOTES

Major Kenneth Gordon, C.B.E., M.C., M.A., F.Inst.Pet., has been awarded the Melchett Medal of the Institute of Fuel for 1947 for his work on hydrogenation.

Dr Gustav Egloff, F.Inst.Pet., has been elected president of the Chicago Technical Societies Council, a federation of 50 scientific societies in the Chicago area.

Sir Kenneth Harper, A.M.Inst.Pet., has been appointed to the board of the Anglo-Iranian Oil Co. Ltd. He has long been associated with The Burmah Oil Co. Ltd., and became its General Manager in the East in 1929 and a Director in 1937.

G. C. Whigham has, on medical advice, resigned his Directorships of The Burmah Oil Co. Ltd. and Anglo-Iranian Oil Co. Ltd. He was appointed a Director of the former at the end of World War I, and of the latter in 1925.

F. H. Braybrook, M.A., F.Inst.Pet., has been appointed as head of the Management of Industrial Development set up by "Shell" Board to advise Managing Directors on world-wide technical developments affecting the petroleum-chemical industry and to be responsible for long range planning of the Group's industrial developments. Previously Manager of Technical (now Chemical) Products Department of the Shell Petroleum Co. Ltd., Mr Braybrook will have as his general assistant *W. F. Mitchell*, (previously Sales Manager of Shell Oil Co. of Canada). Dr *W. S. Matthews*, (formerly of I.C.I. Billingham Group), will head the Division of Industrial Development Planning, *A. V. Billinghame* and *L. W. Leyland Cole* will be jointly in charge of the Division of Market Research, and *A. D. Koeleman* will be responsible for patent policy.

C. R. Wagner, M.Inst.Pet., secretary of the Petroleum Division of the American Chemical Society, has been made vice-president in charge of development and research of General Airline and Film Corpn. He was research director for Pure Oil Co. for many years prior to 1942, when he became a consultant.

U.K. PETROLEUM CONSUMPTION

During the first half of 1947 the total quantity of hydrocarbon oils entered for home consumption in the United Kingdom was 36·1 per cent higher than in the corresponding period of 1938. Details from the official returns* are given in the accompanying table and show that the most spectacular increase

	January to June		
	1947	1946	1938
	Million gallons		
LIGHT OILS			
Motor spirit ..	663·1	542·6	649·6
Other sorts ..	22·1	19·9	16·7
HEAVY OILS			
Road fuel oil ..	78·3	64·9	40·3
Other fuel oil ..	203·7	52·2	154·8
Kerosine	210·1	175·7	103·1
Lubricating oil ..	70·4	66·5	63·8
Gas oil	198·5	136·5	34·0
Other heavy oils ..	4·2	1·7	3·2
Total ..	1,450·4	1,060·1	1,065·5

in the post- over the pre-war comparable periods was for gas oil—an increase of 483·8 per cent. Next in magnitude were kerosine (103·8 per cent), road fuel oil (94·3 per cent), and other fuel oil (31·6 per cent).

SCOTTISH BRANCH VISIT
COMRIE COLLIERY

On July 30 members of the Scottish Branch of the Institute visited the Comrie Colliery, Fife, at the invitation of the National Coal Board. After descending the 220 fathoms to the pit bottom the party was conveyed a distance of one and half miles by diesel train to a development working face where a Joy loader was seen filling a 3½-ton truck in just over a minute. Other modern mechanical devices were demonstrated, including a tippler which unloads the 3½-ton trucks without the necessity of uncoupling.

Returning to the surface, the skip-winding shaft, which brings 10½ tons to the surface per wind, was examined together with other surface equipment. This colliery is an outstanding model of advanced mining practice, comparable with any other installation in the world, and will provide valuable experience in opening up new collieries.

The visitors then proceeded to the Dollar Pit, about 9 miles distant from Comrie, where luncheon was served, and Mr G. R. Buchanan extended a formal welcome on behalf of the Board. Mr J. M. Caldwell responded and expressed the indebtedness of the visitors for the opportunity of inspecting the various installations.

After lunch short visits were paid to the Dollar Pit and to the Meta briquetting and brick-making plants at Alloa.

SOUTH AFRICAN TORBANITE

Details of the production and refining of torbanite in South Africa† are reported by the U.S. Bureau of Mines‡ as follows:

Year ended June 25	*Torbanite Retorted Short Tons*	*Crude Oil Extracted Total Barrels*	*Yield Barrel/ton*
1937 ..	19,024	18,143	0·95
1938 ..	33,000	36,861	1·12
1939 ..	55,098	73,355	1·33
1940 ..	55,747	72,544	1·30
1941 ..	90,959	120,026	1·32
1942 ..	123,031	182,090	1·48
1943 ..	130,205	172,556	1·33
1944 ..	126,030	172,863	1·37
1945 ..	133,588	180,544	1·35
1946 ..	124,133	160,946	1·30

* "Accounts Relating to Trade and Navigation of the United Kingdom, July 1947." H.M.S.O., 4*s*. 6*d*.
† Data supplied by S. A. Torbanite Mining & Refining Co. Ltd.
‡ *Internat. Petrol. Trade*, 1947, **16**, 93.

THE REFINING OF BRITISH PETROLEUM

By J. S. PARKER, M.A., B.Sc., F.Inst.Pet.

In scheduling the processes to be adopted for the refining of a crude oil the refiner is guided by (*a*) a complete laboratory analysis of the crude oil and (*b*) a profitability statement based on this analysis.

In a previous article* on the quality of British petroleum the guiding features of the laboratory analysis were given. The indications were that lubricating oils and wax were both present in an economic percentage and that both were capable of being processed without difficulty for top grade products. Laboratory guidance scheduled indigenous crude oil as primarily suitable for the production of lubricating oils and wax.

Profitability would also favour this process. Indigenous crude oil is, however, in receipt of a preference and the manner in which this preference operates throws considerable weight from the angle of profitability on the side of refining for motor spirit and gas oil. In this respect indigenous crude oil is probably a unique crude from the standpoint of refining economics and thus a brief survey of the problem might be given.

Indigenous crude oil is in receipt of a duty preference which is obtainable from the products derived from the crude oil and not directly from the crude oil itself.

Duty is payable on all imported liquid petroleum products. Liquid petroleum products in the case of indigenous crude oil would comprise everything but the wax, which is solid.

Two rates of duty are in operation, ninepence a gallon on motor spirit,

The Alco Distillation Unit at the Ellesmere Port Refinery is an impressive sight when illuminated at night

* *Institute of Petroleum Review*, 1947, 1, 265.

white spirit and gas oil when utilized as fuel for road vehicles and a penny a gallon on all other liquid products. A home refiner, at date, would receive eightpence a gallon for motor spirit and 2*s*. 2*d*. a gallon for a top grade motor oil. If he refined these from indigenous crude oil the preference would make the products duty free and thus he would obtain eightpence plus ninepence or 1*s*. 5*d*. a gallon for indigenous motor spirit and 2*s*. 2*d*. plus a penny or 2*s*. 3*d*. a gallon for indigenous motor oil. The preference thus places a premium to the extent of the difference between ninepence and a penny, or eightpence a gallon, on the manufacture of motor spirit and road vehicle gas oil.

Indigenous crude oil contains a range of these high-priced lubricating oils, and it also contains wax which commands an even higher price than the lubricating oils. The 2*s*. 2*d*. a gallon for lubricating oil as against eightpence a gallon for motor spirit is based on the fact that the refining cost of lubricating oil is considerably higher than that for motor spirit. There are thus more pennies to play with in the refining cost of lubricating oil and if the lubricating oil can be refined easily and consequently cheaply there is a possibility of off-setting the eightpence a gallon duty preference differential.

The profitability side of the refining of indigenous crude oil is thus a difficult statistical problem. It is further complicated by the fact that, unless the indigenous crude oil tonnage is sufficient to keep the refinery concerned fully occupied, in all probability imported crude oil would be additionally refined. This would necessitate segregation of tankage into dutiable and duty free. Lubricating oils and wax involve a considerable number of tanks. Thermal cracking results in a minimum of products and consequently involves a minimum of tanks. Storage costs money and consequently there is additional profitability weight in favour of thermal cracking. Where, however, the refinery can substitute indigenous for a similar imported crude oil, as was the case at Lobitos, this problem does not arise.

The problem can best be covered by the statement that, if plant and marketing conditions are favourable, indigenous crude oil can be refined for lubricating oils and wax on a profitability par with thermal cracking for motor spirit and road vehicle gas oil. These conditions are more exceptional than normal, and thus the preference weights the profitability in favour of the thermal cracking of the fractions which would otherwise go to lubricating oils and wax.

From the initial attainment of the commercial production of indigenous crude oil, the Anglo-Iranian Oil Co. handled the crude oil within their own group. Tonnage was of the order of 2000 a month and this was shipped by special train from Eakring to their refinery at Grangemouth, Scotland. Here it was subjected to distillation and thermal cracking operations so designed that a maximum percentage of motor spirit and road vehicle gas oil was obtained.

This coincided more or less with the commencement of the last war. Until 1941 the home refineries operated as unit companies. During 1941 the majority of the home refineries were co-ordinated under the control of the Petroleum Board.

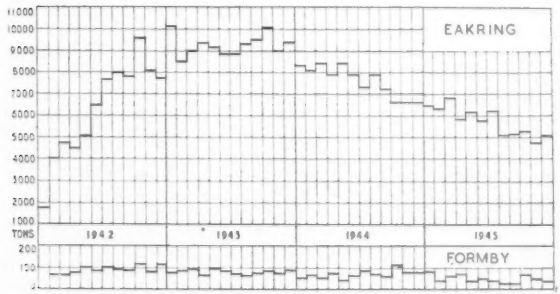
Towards the end of 1941 two problems on the question of indigenous crude oil arose for consideration. The shipment of the crude oil to Grangemouth involved a long haul. The route traversed the N.E. coast rail bottleneck. A shorter haul west would tie up fewer railcars and cause less rail congestion. Crude oil production at this period was up to 4000 tons a month and was on the increase. Under the war conditions prevailing, lubricating oils and wax were a more difficult supply proposition than motor spirit and road vehicle gas oil.

The outcome of this consideration was an arrangement by which the Petroleum Board took delivery of the crude oil from the Anglo-Iranian Oil Co. at its Eakring rail sidings and shipped it by rail to Ellesmere Port, Cheshire, where it was refined for lubricating oils and wax on behalf of the Petroleum Board, by Lobitos Oilfields Ltd. This arrangement was brought into effect at the beginning of 1942, and has continued to date.

From the standpoint of refining economics, which were not as has been shown a major consideration under the war conditions prevailing, the arrangement was a particularly happy one. The Lobitos refinery was fully equipped for the manufacture of lubricating oils and wax with the additional possibility of thermal cracking if and when this might be required. It was rated at 100,000 tons crude oil per annum, 50 per cent waxy and 50 per cent non-waxy. Indigenous crude oil fitted into the waxy at 4000 tons a month and when the production peaked at 10,000 tons a month it was still within the refinery capacity.

The crude oil was shipped by special train made up to the rail haulage limit of just over 500 tons crude oil, contained in about thirty-eight railcars. The railcar complement for this service was roughly the equivalent of three trains. At the production peak 10,100 tons crude oil was shipped per month or one train-load every thirty-six hours. The crude oil from the small Formby field was brought in by Scammell road wagons averaging about eleven tons each trip.

The refinery was designed for the receipt of crude oil by tanker and the despatch of products by road and rail. The receipt of crude oil by rail involved throwing a considerable extra load on the rail sidings. Further a speedy turn round of railcars was required. It was estimated that the requirement could be met by unloading three sets of six railcars at a time, and arrangements were made to this effect. A few days before this could be checked in operation a near miss and consequent fire did considerable damage to the rail sidings. These were repaired in record time to take two sets of six unloading points, and though a third set was eventually put in it was never required except as a reserve. The two sets of six proved to be sufficient.



Monthly gross receipts of British crude oil at the Lobitos Oilfields Ltd. Refinery

The switch from Grangemouth to Ellesmere Port was scheduled for the beginning of January 1942. The pour-point on a prior well sample of the crude oil had been checked at 60°F, which raised doubts about the pumping possibilities in view of the fact that the railcars allocated were neither steam coiled nor lagged. A laboratory check indicated that the crude oil had an upper and a lower pour-point, the range between the two being of the order of 75°F. The crude oil remained a pumping proposition from 10° to 20° below

its upper pour-point. Also the pour-point of the average crude oil was below 60 F.

Practice soon had a chance to prove this under the worst unloading condition as a heavy snowstorm considerably delayed the first train load. When the train eventually arrived the crude oil temperature was about freezing point, but the crude was just pumpable.

These two incidents right at the outset were the only delaying features experienced in the steady flow of the crude oil from field to refinery.

The railcars were unloaded over the top through the usual swing arm terminated by a 4-in armoured hose. The two 6-in headers were manifolded into the suction of an 8 in × 8 in × 10 in duplex D.A. pump alongside the rail siding which pumped through a 6-in line to main storage. Pumping speed was of the order of 70 tons an hour. This speed dropped at low temperature, but on no occasion was the crude oil unpumpable from the uncoiled railcars.

The crude oil was stored in 7,000 or 10,000 ton steam-coiled storage tanks and a stock of 10,000 tons was built up and maintained throughout (*a*) to act as a reserve against the possibility of transport breakdown and (*b*) to reduce the water content from the 2 per cent limit to the 0·5 per cent required for maximum production on the distillation unit.

From the main storage tanks the crude oil was pumped to an Alco distillation unit where it was distilled into three atmospheric products, one vacuum overhead, four vacuum sidestreams, and a vacuum residue. The product cuts remained standard at light benzine, white spirit, gas oil, light spindle, heavy spindle, light lube, heavy lube, cylinder stock, and vacuum residue.

The light spindle contained only a wax trace and was, to a large extent, cut back into the gas oil. The front end of the wax showed up in the heavy spindle.

The average product percentages were as follows:

	Per cent by vol.
Light benzine	9·0
White spirit	7·9
Pool gas oil	34·4
Pool 5 distillate	12·0
Pool 11 distillate	3·7
Pool 12 distillate	8·8
Pool 13 distillate	1·4
Vacuum residue	22·7
Loss	0·1
	100·0

Full-rated throughput was easily maintained on this crude. The only abnormal feature was the vicious HCl corrosion of tube bundles compared with the small salt content of the crude. It was necessary to inject ammonia into the vapour lines.

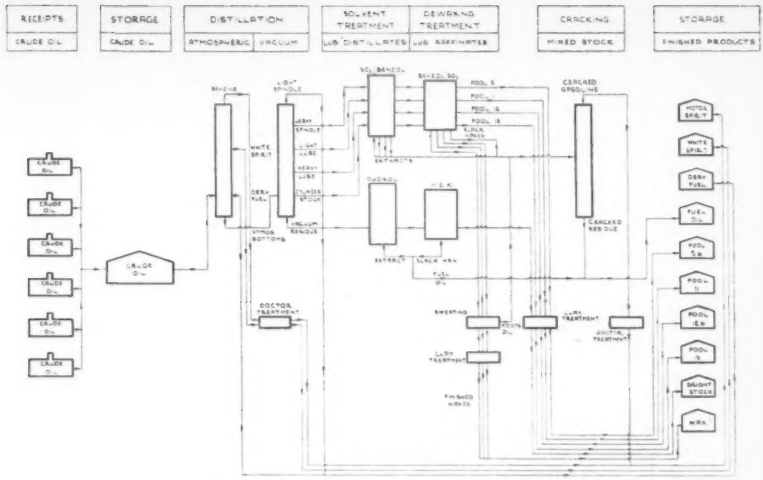
The light benzine was given a doctor treatment and was blended back with indigenous cracked gasoline to obtain front end volatility and an octane number of 70. The blend was made up in accordance with the ruling service requirement.

The white spirit was given a doctor treatment and was marketed in accordance with the ruling Pool specification.

The gas oil was marketed straight or blended with a minor percentage of light spindle distillate. The diesel index was around 58. The main usage was as road vehicle fuel.

The waxy lubricating oil distillates were solvent treated and solvent dewaxed on a combination SO_2/benzol unit designed for this purpose. These units were developed to a practical scale just prior to the last war.

The principle consists of the multiple stage treatment of the distillate with a solvent comprised of say, 90 per cent



Flow sheet of the distillation and refining British crude oil

SO_2 and 10 per cent benzol. The raffinate from this treatment, after removal of the solvent, is carried forward and mixed with solvent comprised of say, 10 per cent SO_2 and 90 per cent benzol. This mixture is chilled, using SO_2 for the refrigeration, and passed through rotary filters where the wax content is removed.

The resulting products from the combined operation were filtrate, slack wax and extract. The solvents were recovered by evaporation and condensation or compression and re-used.

This unit though not far advanced from the pilot plant stage operated satisfactorily throughout the war at full-rated throughput.

Taking the waxy lubricating oil distillates in the order light to heavy, Pool 5 distillate was mainly treated to produce the top grade heavy spindle type oil Pool 5b. The average yields by weight from the required treatment were filtrate 62·6 per cent, extract 20·6 per cent, and slack wax 16·8 per cent.

[Photo by Aerofilms Ltd.

An aerial view of Lobitos Oilfields Refinery at Ellesmere Port

Pool 5	*Distillate*	*Filtrate*	*Extract*
Sp. gr. at 60°F ..	0·882	0·868	0·971
Flash-point (P.M. closed), °F ..	420	415	405
Red. I. Visc. at 140°F, sec	63	64	122
Pour-point, °F ..	85	20	65
Acidity, MgKOH/g	0·04	—	—
Wax content, % by vol.	17	—	—
Colour (A.S.T.M.). ..	—	1	—
Visc (Kin) at 100°F, cs	—	32·2	—
Visc (Kin) at 210°F, cs	—	5·12	—
Visc. Index	—	94	—

Melting point of slack wax 125°F.
Melting point of pure wax 128°F.

Pool 11 distillate was treated for the light lube type Pool 11. The average yields by weight from the required treatment were filtrate 65·6 per cent, extract 17·6 per cent, and slack wax 16·8 per cent.

Pool 11	*Distillate*	*Filtrate*	*Extract*
Sp. gr. at 60° F ..	0·892	0·883	1·009
Flash-point (P.M. closed), °F ..	465	450	450
Red. I. Visc. at 140° F, sec	96	104	97 (200°F)
Pour-point, °F ..	100	20	30
Acidity, MgKOH/g ..	0·03	—	—
Colour (A.S.T.M.) ..	—	2	—
Visc (Kin) at 100°F, cs	—	67·2	—
Visc (Kin) at 210°F, cs	—	7·77	—
Visc. Index	—	85·5	—

Melting point of slack wax 138°F.
Melting point of pure wax 142 °F.

Pool 12 distillate was treated for the top grade heavy lube type 12b. The average yields by weight from the required treatment were filtrate 63·0 per cent, extract 20·3 per cent, and slack wax 16·7 per cent.

Pool 12	*Distillate*	*Filtrate*	*Extract*
Sp. gr. at 60°F ..	0·902	0·886	1·003
Flash-point (P.M. closed), °F ..	490	490	475
Red. I. Visc. at 140°F, sec	215	196	254 (200°F)
Pour-point, °F ..	115	25	55
Acidity, MgKOH/g ..	0·03	—	—
Wax content, % by wt	13	—	—
Colour (A.S.T.M.) ..	—	4–	—
Visc (Kin) at 100°F, cs	—	146·0	—
Visc (Kin) at 210°F, cs	—	13·0	—
Visc. Index	—	88·5	—

Melting point of slack wax 137°F.
Melting point of pure wax 140°F.

Pool 13 distillate or cylinder stock was present in small percentage and was consequently mainly adjusted back into the pool 12 distillate. Small batches were treated from which the average yields by weight for the required treatment were filtrate 37·2 per cent, extract 28·5 per cent, and slack wax 34·3 per cent.

Pool 13	*Distillate*	*Filtrate*	*Extract*
Sp. gr. at 60°F ..	0·910	0·888	0·995
Flash-point (P.M. closed), °F ..	495	475	465
Red. I. Visc. at 140°F, sec	266	243	222 (200°F)
Pour-point, °F ..	110	15	60
Acidity, MgKOH/g ..	0·03	—	—
Colour (A.S.T.M.). ..	—	3	—
Visc (Kin) at 100°F, cs	—	188·3	—
Visc (Kin) at 210°F, cs	—	15·22	—
Visc. Index	—	87	—

Melting point of slack wax 130°F.
Melting point of pure wax 139°F.

The slack waxes up to Grade 12 were de-oiled by conventional sweating methods. As the waxes were solvent refined, a finishing clay treatment of 0·5 per cent clay was sufficient.

Slack waxes were blended and sweated according to the wax grades required.

The finished wax was slabbed in a 1-ton capacity slabbing machine.

	Grade 5 H.P.	*Grade 6 H.P.*	*Grade 7 H.P.*
Sp. gr. at 60°F ..	0·818	0·817	0·816
Setting point (I.P.), °F	142·3	138·0	134·9
Colour (Lovibond 5-in cell)	0·2Y.	0·4Y.	0·3Y.
Flash-point (P.M. closed), °F ..	445	440	445

Solvent extraction processes are not equally efficient throughout the lubricating oil range. The Edeleanu process has its greatest efficiency in the treatment of spindle oils. As the viscosity increases from light lube to heavy lube so the treatment efficiency drops. Benzol is used as a diluent to aid the action in the case of the more viscous oils. Pool 13 distillate is approaching the borderline for SO_2/benzol treatment.

It was known that there was an economic percentage of lubricating oil of bright stock type in the vacuum residue and that the wax present in it was amorphous. This was outside the range of Edeleanu solvent treatment and the rotary filters on the wax side were not suited for handling amorphous wax.

Thus, initially, the vacuum residue was cracked.

Later, other arrangements were made and for the major part of the war the vacuum residue was pumped over to the "Shell" Refining and Marketing Co. Ltd., where it was subjected to Duosol treatment followed by MEK/benzol dewaxing. Worthy of mention are the crews who, no matter the weather prevailing, never failed to transfer this highly viscous vacuum residue through about a mile of bare overground pipeline.

A near-miss and consequent fire did considerable damage to the rail sidings, but repairs were executed in record time

Duosol, utilizing as the name implies, two solvents—propane and a creosote-type solvent termed selecto—has its highest efficiency on viscous oil operation. Dewaxing of the solvent extracted oil or raffinate was carried out on a separate plant utilizing methyl ethyl ketone in combination with benzol, with wax removal by Vallez leaf filters which operate efficiently on amorphous wax.

The required Duosol treatment resulted in the following percentages by weight, waxy raffinate 49 and extract 51.

	Vacuum Residue	*Waxy Raffinate*	*Extract*
Sp. gr.	0·933 (60°F)	0·855 (70°C/60°F)	0·956 (120°C/60°F)
Red. I. Visc. at 140°F, sec	5,200	—	—
Penetration at 25°C ..	—	—	109
Flash-point, (P.M. closed), °F ..	505	485	515
Pour-point, °F ..	75	—	—
Wax content, % by wt	—	21	—

The required MEK/benzol treatment gave the following percentages by weight, dewaxed raffinate 77, and slack wax 23.

	Dewaxed Raffinate	*Slack Wax*
Sp. gr.	0·893 (60°/60°F)	0·832 (70°C/60°F)
Flash-point (P.M. closed), °F ..	495	490
Visc (Kin) at 100°F, cs	934·8	—
Visc (Kin) at 210°F, cs	44,54	—
Visc. Index	96	—
Congealing point (I.P. 76/44T), °C.. ..	—	60
Wax content, % by wt.	—	86 6

The dewaxed raffinate was given a clay treatment of 3 per cent activated earth, and 0·06 per cent lime at 240° C. with steam. The finished product had the following salient features:

Red. I. Visc. at 140°F sec	920
Visc. Index	96
Pour-point, °F ..	10
Colour (Union), dil. ..	5 (0)
B.A.M. oxidation test:	
Coke No., before ..	0·57
Coke No., after ..	1·22
Coke No., increment	0·65

This finished oil was absorbed into Air Ministry lubricating oil production.

The refinery was operated mainly for the production of lubricating oils and wax with a veto on cracking as a regular operation. The cracking plant was only operated to even out the load and was thus called on to handle a wide variety of cracking stock.

Unsweatable slack waxes, foots oils, extracts, vacuum residue, distillates, and even crude oil were all on occasion cracked down as mixed cracking stock for motor spirit and fuel oil. From a

typical mixed stock containing by weight 70 per cent slack wax and lube distillate, 18 per cent extract and 12 per cent vacuum residue, was obtained by weight 40 per cent cracked gasoline and 47 per cent residuum. The cracked gasoline had an octane number (A.S.T.M.) of 74, and the residuum a Red. II Visc at 140° F of 50 sec.

During the war years 1942 to 1945 the following tonnages of major products obtained from indigenous crude oil were manufactured and distributed by the Lobitos refinery:

	Tons
Motor spirit	47,600
White spirit	18,300
Gas oil	107,900
Lubricating oils	30,000
Paraffin wax	4,300

These products went into the common pool distributed by the Petroleum Board. Their eventual history is part of the history of the co-operative effort put forward by the petroleum industry as a whole. In that history it will be found that these indigenous products played no small part in fuelling and lubricating the war machines. Their more obvious usefulness in saving ship-miles is apparent from the tonnages involved.

FOURTH EMPIRE MINING AND METALLURGICAL CONGRESS

The President (Sir Henry T. Tizard, K.C.B., A.F.C.), and Organizing Committee of the Fourth Empire Mining and Metallurgical Congress have found it advisable to postpone the Congress, which was to have been held in London in 1948, until June or July, 1949.

This decision was reached with great reluctance, but improvement in travelling and other facilities has been less than was anticipated, and the present outlook would seem to indicate the desirability of postponement until 1949.

The Committee trust that those who had planned to attend the Congress will not be greatly inconvenienced by this postponement, which should, however, facilitate the arrangement of a more comprehensive programme.

FORTHCOMING MEETINGS

INSTITUTE MEETINGS

Metallurgical Methods for Combating Corrosion and Abrasion in the Petroleum Industry. B. B. Morton. At 26 Portland Place, London, W.1. 5 p.m. October 8.

Rheological Investigation of Asphaltic Bitumen in Connexion with its Technical Applications. R. N. J. Saal. At 26 Portland Place, London, W.1. 5 p.m. November 12.

Examination of Used Engine Lubricating Oils. K. Hilfreich, J. C. McNicol, and L. Rosenfeld. At 26 Portland Place, London, W.1. 5 p.m. December 10.

MEETINGS OF OTHER SOCIETIES

High Speed C.I. Engines. S. Markland and N. Tattersall. The Institution of Mechanical Engineers, London. 6 p.m. October 7.

Hydrogenation in the Fuel and Chemical Industries. K. Gordon (Melchett Lecture). The Institute of Fuel, at Gas Industry House, 1 Grosvenor Place, London, S.W.1. 2.30 p.m. October 16.

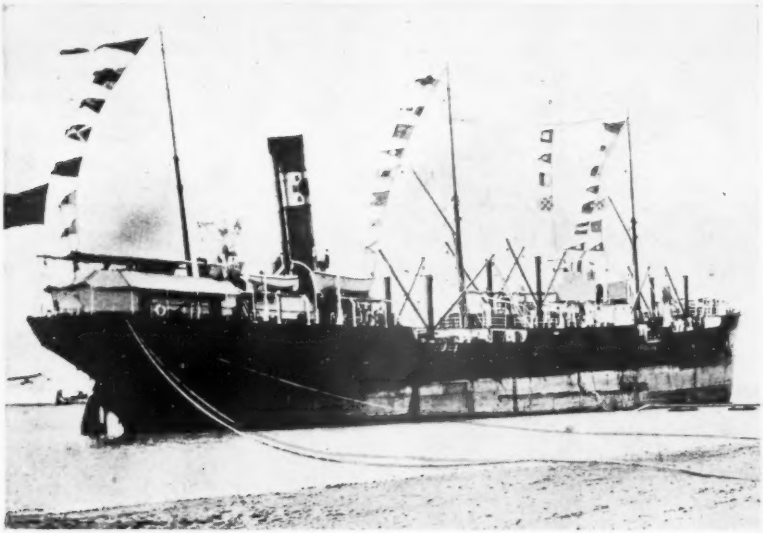
Crystallographic Technique and its Chemical Significance. Prof. E. G. Cox. The Chemical Society (Tilden Lecture), London. 7.30 p.m. October 23.

Addition Polymerization. Prof. D. H. Hey. The Chemical Society, at University College, Hull. 6 p.m. October 23.

The Oxidation of Phenols. Prof. R. D. Haworth. The Chemical Society, at the University, Bristol. November 6.

The Engining of Cargo Vessels of High Power. Symposium. The Institute of Marine Engineers, London. 2.30 p.m. November 11 and 12.

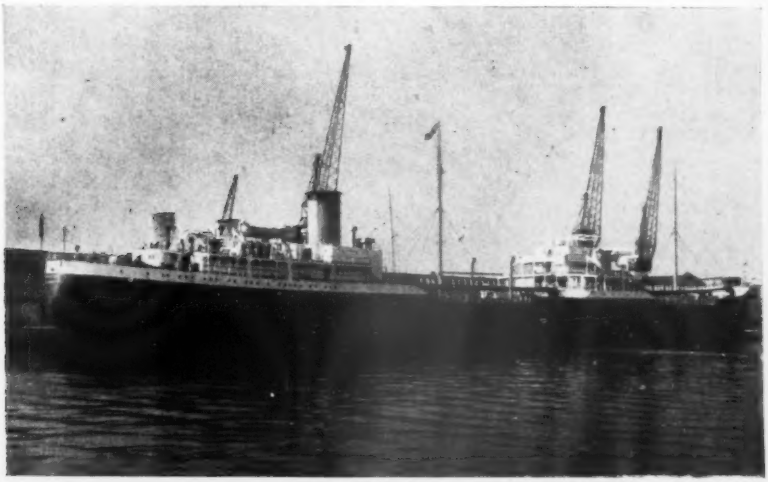
The Burning of Boiler Fuels in Diesel Engines. J. Lamb. The Institute of Marine Engineers, London. 5 p.m. December 9 (paper), December 10 (discussion).



THEN AND NOW

Above, the SS. Nerite, *one of the original Shell fleet, is seen discharging the first cargo of liquid fuel at Suez in October 1899.*

Below, the TES Helicina, *flagship of the tanker fleet of the Anglo-Saxon Petroleum Co. Ltd., at Southampton on October 29, 1946.*



[Photos by courtesy of "Shell" Refining & Marketing Co. Ltd.

U.K. PETROLEUM TRADE IN FIRST HALF OF 1947

By GEORGE SELL, F.Inst.Pet.

DURING the first half of 1947 imports of crude petroleum and refined products totalled 1,484,350,000 gallons, a decrease of 450,581,000 gallons (23·3 per cent), from the total for the same period of 1946, and 117,404,000 gallons (7·3 per cent), less than half the total for the year 1938. Comparing the 1947 and 1946 periods slight increases are noted for crude petroleum and lubricating oil, while motor spirit dropped by 23 per cent, gas oil 44 per cent, and fuel oil and diesel oil 43 per cent. Details from the official returns* are given in Table I.

Total value of crude and refined petroleum in the 1947 period was £39,720,523, a decrease of £4,305,793 (10 per cent) from the corresponding 1946 total but nearly double the £22,990,100 which these imports cost for half the year 1938.

In Table II the c.i.f. values have been calculated on a unit basis, the unit being that used in the official return, i.e., 1000 gallons for liquids, and hundredweights or tons for solids and semi-solids. This permits a direct comparison of values and it is of interest to note how values have risen in 1947 in comparison with 1946.

TABLE I

QUANTITY AND VALUE OF U.K. PETROLEUM IMPORTS

	January to June 1947		*January to June* 1946		*Half year* 1938	
	Quantity 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £
Crude petroleum ..	297,667	6,266,571	259,390	4,474,442	283,978	2,588,768
Motor spirit	569,820	16,464,881	738,754	18,895,229	728,334	12,382,462
Other spirit	11,519	392,984	16,893	474,518	9,048	155,292
Kerosine	170,163	4,518,884	198,414	4,522,884	103,182	1,502,240
Lubricating oil ..	49,751	3,790,060	41,271	2,599,253	54,100	1,976,908
Gas oil	144,782	3,429,464	258,005	5,504,980	78,964	1,062,808
Fuel oil and diesel oil	240,648	4,857,655	422,204	7,554,971	343,670	3,285,230
Other sorts	—	24	—	39	478	36,392
Total refined products	1,186,683	£33,453,952	1,675,541	£39,551,874	1,317,776	£20,401,332
	Cwt.		*Cwt.*		*Cwt.*	
Paraffin wax	349,203	1,026,367	344,168	656,327	404,876	317,520
Mineral jelly ..	113,792	198,184	64,622	91,068	68,190	77,866
Carbon black from natural gas ..	279,980	783,062	293,410	707,205	193,106	256,376
	Tons		*Tons*		*Tons*	
Natural asphalt and bitumen	14,398	171,730	12,290	140,585	39,582	145,472
Manufactured bituminous asphalt and emulsions ..	150	4,640	437	7,607	26,028	137,768

* "Accounts Relating to Trade and Navigation of the United Kingdom, July 1947." H.M.S.O., 4*s.* 6*d.*

TABLE II

AVERAGE VALUES OF U.K. PETROLEUM IMPORTS

	January to June		Half year
	1947	1946	1938
	£ per 1000 gal.		
Crude petroleum ..	21·05	17·25	9·12
Motor spirit	28·89	25·58	17·00
Other spirit	34·12	28·09	17·16
Kerosine	26·56	22·80	14·56
Lubricating oil ..	76·18	62·98	36·54
Gas oil	23·69	21·34	13·46
Fuel oil and diesel oil	20·19	17·89	9·56
Other sorts	—	—	76·13
Total refined products	28·19	23·61	15·48
	£ per cwt.		
Paraffin wax ..	2·94	1·91	0·78
Mineral jelly ..	1·74	1·41	1·14
Carbon black ..	2·80	2·41	1·33
	£ per ton		
Natural asphalt and bitumen	11·93	11·44	3·68
Manufactured bituminous asphalt and emulsions ..	30·93	17·41	5·29

Consigning Countries

Such details as are given in the official return as to consigning countries, which are not necessarily the country of origin of the material, are given in Table III. Of the total imports countries of the British Empire were consignors of 13·1 per cent in 1947, 8·4 per cent in 1946, and 7·9 per cent in 1938.

In regard to the foreign countries consigning petroleum to the United Kingdom in the comparable periods of 1947 and 1946, the reduced totals from the Netherlands West Indies, the United States, and Iran are noteworthy. In the case of the N.W.I. the reduction is mainly in fuel oil and diesel oil, offset by increases in gas oil and kerosine. For the United States the principal decreases are for gas oil and fuel oil and diesel oil, with noteworthy increases in motor spirit and lubricating oil. Motor spirit imports from Iran were almost negligible in the first half of 1947 in comparison with 1946; kerosine and gas oil were also much lower but crude oil and fuel oil and diesel oil both showed increases.

U.K. imports from Venezuela were nearly 50 per cent higher in 1947 than in 1946, this being due to enhanced shipments of crude oil and of motor spirit.

TABLE III

COUNTRIES CONSIGNING PETROLEUM TO THE U.K.

Country and Product	*January to June* 1947	1946	*Half year* 1938
	Thousand gallons		
British West Indies			
Motor spirit ..	45,687	56,784	45,304
Kerosine ..	40,699	43,867	—
Fuel and diesel oils	37,972	30,121	59,068
	124,358	130,772	104,372
Other British:			
Crude petroleum	26,012	2	10,196
Motor spirit ..	11,892	24,414	4,012
Kerosine ..	19,900	1,177	1,428
Lubricating oil ..	92	173	40
Gas oil	6,630	3,976	6,020
Fuel and diesel oils	6,110	1,600	598
	70,636	31,342	22,294
Neth. West Indies			
Crude petroleum	98,629	115,396	80,392
Motor spirit ..	187,622	183,432	294,764
Kerosine ..	56,448	41,508	25,446
Lubricating oil ..	11,119	10,862	—
Gas oil	32,612	9,985	10,968
Fuel and diesel oils	61,531	215,088	125,644
	447,961	576,271	537,214
United States:			
Crude petroleum	6,163	37,137	7,498
Motor spirit ..	272,772	208,973	157,248
Kerosine ..	32,389	39,740	28,900
Lubricating oil ..	38,505	30,205	42,830
Gas oil	85,249	211,360	19,702
Fuel and diesel oils	2,280	75,283	31,656
	437,358	602,698	287,834
Iran:			
Crude petroleum	65,689	38,039	27,110
Motor spirit ..	9,992	247,669	157,034
Kerosine ..	17,448	69,078	29,942
Gas oil	1,277	13,155	18,546
Fuel and diesel oils	122,078	93,442	80,682
	216,484	461,383	313,314
Venezuela:			
Crude petroleum	84,210	59,852	69,488
Motor spirit ..	16,954	6,984	—
Fuel and diesel oils	3,570	3,580	6,930
	104,734	70,416	76,418
Palestine: ..			
Motor spirit ..	22,027	10,498	—
Peru:			
Crude petroleum	8,907	8,957	10,932
Iraq:			
Crude petroleum	—	7	70,898
Soviet Union			
Motor spirit ..	—	—	23,730
Lubricating oil ..	—	—	6,680
			30,410
Neth. East Indies:			
Motor spirit ..	—	—	11,928
Other Foreign:			
Crude petroleum	8,057	—	7,464
Motor spirit ..	2,874	—	34,314
Kerosine ..	3,279	3,044	17,466
Lubricating oil ..	35	31	4,550
Gas oil	19,014	19,529	23,728
Fuel and diesel oils	7,107	3,090	39,092
	40,366	25,694	126,614

Re-exports

Total re-exports of imported petroleum in the first half of 1947 were 78 per cent higher than in the same period of 1946. As seen in Table IV, the quantity of motor spirit re-exported was nearly doubled and fuel oil and diesel oil reached a record high level.

As bunker fuel is not an "export" in the ordinary acceptance of the term, no value is given.

TABLE IV

U.K. RE-EXPORTS OF IMPORTED PETROLEUM

	January to June 1947	1946	*Half Year* 1938
	Thousand gallons		
Motor spirit ..	36,702	19,285	7,038
Kerosine ..	1,416	4,555	1,416
Lubricating oil ..	1,370	3,879	2,172
Fuel oil and diesel oil	22,859	1,140	2,142
All other sorts	2,582	7,625	1,798
	64,929	36,484	14,566
Value ..	£2,143,310	£1,208,555	£400,250
Oil fuel for use in steamers ..	198,290	211,120	156,602

Exports

For the half year of 1947 the U.K. exports of petroleum products manufactured or produced in the U.K. were more than doubled in quantity in comparison with 1946, although the value of £2,227,871 was only 43·4 per cent higher. The details in Table V show that while the exports of lubricating oil showed little change, all the other named products were sent out of the country in much greater quantities than in the same period of the previous year.

TABLE V

U.K. EXPORTS OF HOME PRODUCED AND MANUFACTURED PETROLEUM

	January to June 1947		*January to June* 1946		*Half year* 1938	
	Quantity 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £	*Quantity* 1000 *gal.*	*Value* £
Motor spirit	8,745	306,502	696	27,106	27,492	442,484
Kerosine	724	21,777	26	1,592	6,056	93,180
Lubricating oil ..	13,101	1,513,487	13,319	1,415,505	8,734	580,760
Gas oil	10,229	254,582	288	6,239	14,564	192,218
Fuel oil and diesel oil	3,514	72,218	3	409	8,600	89,170
All other sorts ..	385	59,305	1,173	102,985	1,394	29,158
Total	36,986	£2,227,871	15,505	£1,553,836	66,840	£1,426,970
	Cwt.		*Cwt.*		*Cwt.*	
Lubricating compounds	41,679	130,069	49,637	124,170	302,632	357,182
Paraffin wax	39,432	143,039	8,178	25,905	44,008	37,956
	Tons		*Tons*		*Tons*	
Manufactured bituminous asphalt and emulsions	26,676	318,386	67,560	587,351	45,964	213,030

The Institute of Petroleum Electrical Code. A suggested Code of Electrical Practice applicable to conditions in the petroleum industry. Published by the Institute of Petroleum, 26, Portland Place, London, W.1., pp. 77. Price: 5*s.* post free.

Modern Petroleum Technology. A comprehensive picture of the present state of technical knowledge within the petroleum industry. Published by the Institute of Petroleum, 26, Portland Place, London W.1., pp, 466. Price: £1 1*s.* post free.

TRINIDAD BRANCH DINNER

THE Annual Dinner of the Trinidad Branch of the Institute of Petroleum was held at Port-of-Spain on April 26, 1947. The guests included His Excellency the Governor (Sir John Shaw), and a number of senior government officials and prominent business men of the island. The speeches are summarized below.

Proposing the toast of "His Excellency the Governor," Mr C. C. Wilson, (Chairman of the Branch), said that the new Governor, having recently come from Palestine, must be well acquainted with the oil business. Comparing Trinidad with Iraq it was important to appreciate the vast difference in producing capacity of individual wells. In Iraq drilling into the large limestone reservoir might be likened to drilling into a tank; in Trinidad they were much less fortunate as their oil occurred in irregular sand lenses, like plums in a pudding. Sometimes the plums turned out to be currants or, worse, to carry salt water instead of oil.

Trinidad, continued Mr Wilson, was the largest oil-producing country within the British Empire, and its wartime production of crude oil had amounted to 20 million tons. This production had been made possible by drilling up proven areas, resulting in a considerable depletion of the island's known reserves. Since the war the ambition had been to supplement those reserves by seeking extensions of existing producing areas and developing new fields. Exploratory work had been intensified and drilling had been extended to the extremities of the present fields but developments had been delayed by continuous set-backs to supplies from England and the complications of dollar exchange. A further hindrance to the exploratory work lay in the chaotic condition of land titles, although he understood this was likely to be cleared up shortly.

The area of Trinidad had been increased by the marine concessions, into which the oil-producing areas might extend. With the additional cost of building foundations for drilling in rough water up to 25 fathoms deep the drilling cost would be near to, if it did not exceed, the value of oil recoverable from an average Trinidad well. If the cost of marine drilling could be reduced to an economic level, then the marine areas might well prolong the life of Trinidad's oil industry. It was a challenge which the technologists would accept with enthusiasm.

The biggest and best advertisement of our industry, said Mr Wilson, is the Pointe-á-Pierre refinery with its constant stream of tankers, its acres of gleaming silver tanks, stills, and fractionating columns, and its distinctive aroma. Now the name "Regent Gasoline", familiar in England but new to Trinidad, is picturesquely displayed in Pointe-á-Pierre in a new filling station of the "South American way" type where one is even lured to fill up with gasoline in the hope of a glimpse of Carmen Miranda on the balcony.

Sir John Shaw, in reply, said he was happy to find himself in a familiar and congenial atmosphere of petroleum-minded people. He had been to the Pointe-á-Pierre refinery, and had seen a remarkable likeness to the refinery at Haifa—and had heard the familiar jargon.

He sometimes wondered whether it might not have been better if petroleum had never been discovered, and we were still travelling about on horse-back and in coaches.

Trinidad was fortunate from the economic, industrial, and social points of view in having the oil industry to supplement and assist its basic economy, which is agriculture. He concluded by wishing the industry the best of luck

in its further development and progression for the good of the colony of Trinidad and Tobago.

The Industries of Trinidad

The toast of "The Industries of Trinidad" was proposed by the Hon W. M. V. Ash, who said that he believed the oil industry was facing a period of tremendous change, not only technological but also economic. In 1943 the U.S. Government sent a technical mission to study the oil potentialities of the Middle East. The head of the mission, Mr E. DeGolyer, opened his preliminary report with these words: "The centre of gravity of world oil production is shifting from the Gulf-Caribbean area to the Middle East-Persian Gulf area, and is likely to shift until it is firmly established there." Later in the report it is stated that: "Any one of the Middle East countries can develop and maintain within its own properties, given reasonable time and a very moderate amount of oilfield material, a production sufficient to supply world requirements from the Middle East for many years to come."

The mere fact of the availability of such a tremendous resource is likely to create revolutionary changes in world oil supply lines, and may mean that the oilfields of the Western Hemisphere will need to find or create new markets nearer home. This situation faces Trinidad at a time when the finding of new fields and reserves is vital to the continued well-being of its oil industry, said Mr Ash. For many years oil has been taken out of the ground faster than new reserves could be discovered to replace it. It is necessary to drill deeper and deeper for the oil as time goes on, and in consequence the curve of production goes down as the curve of costs goes up.

On the refining side obsolescent equipment needs constant replacement and plant to treat 80,000 barrels per day—about the present volume of Trinidad production—would cost to-day about two and a half times its pre-war cost.

Concluding, Mr Ash thought that Trinidad should take a lesson from her neighbours and endeavour to preserve an economy not wholly dependent on a transient asset like oil. Other industries should be given their part to play, and he was sure they would maintain and add to their substantial achievements of the past.

The Hon Alan Storey, (President of the Chamber of Commerce), in reply, said it was important that the industrial community should realize that in 1946 the colony had a visible adverse balance of trade of $18,000,000, compared with a favourable balance averaging $1,000,000 per year before the war. The contribution of the oil industry to Trinidad's exports in 1946 was the magnificent total of 74 per cent.

To-day new capital is needed for the exploitation and development of Trinidad's raw material resources, but the prospects of reward must be commensurate with the risks. If it is admitted that we have raw materials of high quality and in abundance awaiting exploitation, or conversely that we have cheap sources of fuel and power for processing imported raw materials, then the pre-requisites for industrial expansion are two-fold. First, said Mr Storey, is the progressive improvement in productive capacity of labour at competitive costs judged by international standards and, secondly, a constant flow of new capital attracted not only by prospects of reward commensurate with the risks involved but encouraged by the continued stability of an able administration.

The toast of "Our Guests" was proposed by Mr H. A. Bennett, and responded to by Mr H. J. Page, Principal of the Imperial College of Tropical Agriculture.

BITUMINOUS SAND SEPARATION

THE 1946 Annual Report* of the Research Council of Alberta states that, in regard to bituminous sand studies and the design of the government-sponsored separation plant at Bitumount, various methods have been considered for removing water and mineral matter from the crude separated oil before charging it to the refinery. It was found that a combination of settling at about 170°C and direct evaporation was most feasible and the drying unit has been completed on these lines.

HOT WATER SEPARATION

Study of the hot water separation method has been continued and the distribution of oil in the separation plant has been examined in detail. It has been found that the silt and very fine mineral matter which disperses in the plant water holds a surprising amount of oil. Recovery of oil in the separation of good grades of bituminous sand will be between 80 and 90 per cent, decreasing with increasing content of silt and clay.

WATER FLOODING

It is obvious that the main body of oil in the bituminous sands cannot be won by mining and separation, and the Council is studying the applicability of water-flooding. Results of laboratory tests have been encouraging and further work is to be undertaken.

GASOLINE TESTING

An investigation into the length of time gasoline samples can be stored without change is still in progress.

HYDROCARBON SYNTHESIS

In connexion with a project concerned mainly with the study of catalysts for the conversion of carbon monoxide and hydrogen to hydrocarbons of the gasoline range, six testing units have been in operation since the summer of 1944. Up to April 1946 seventeen catalysts have been prepared and used in tests lasting for 6 to 15 weeks for each catalyst.

Cobalt base catalysts were the most successful the two best being: (1) a Fischer type consisting of cobalt, thorium dioxide, and kieselguhr in the proportions of 82:18:100, and (2) a Hall type of cobalt, thorium dioxide, magnesium oxide, and kieselguhr in the proportions of 100:6:12:200.

Three different procedures of reduction, induction, and operation of catalysts are being tested and different types of kieselguhrs are being used. Surface areas of the kieselguhrs have been determined and the surface area of the catalyst may be related to its activity in the testing unit. Theoretically such a relation may exist but results so far obtained do not indicate a direct relationship.

FUEL ECONOMY

A special course of lectures entitled "Fuel Economy in Relation to Steam Generation and Utilization" are being given at the Northampton Polytechnic, St. John Street, London, E.C.1. The three sections are:

(*a*) "Principles of Combustion and Properties of Steam". Seven lectures on Tuesday evenings at 7 p.m., commencing October 7, 1947. Fee: 10*s*.

(*b*) "Steam Generation". Ten lectures on Tuesday evenings at 7 p.m., commencing November 25, 1947. Fee: 12*s*. 6*d*.

(*c*) "Steam Utilization". Ten lectures on Thursday evenings at 7 p.m., commencing November 27, 1947. Fee: 12*s*. 6*d*.

Admission to the course is by personal enrolment at the Polytechnic Office any day from 10 a.m. to 7 p.m.

* Obtainable from the Secretary, Research Council of Alberta, University of Alberta, Edmonta, Canada. 5 cents.

U.S. PRODUCTION

Crude oil production in the first six months of 1947 amounted to 889,883,000 barrels, an increase of 5 per cent over the figure of 847,752,000 barrels for the same period of 1946. Daily average production for June—5,099,000 barrels—set up a new record, and the daily average for the half year was 4,916,000 barrels compared with 4,684,000 in the first half of 1946.

Details of production and demand released by the Petroleum Economics Division of the U.S. Bureau of mines are:

	January-June	
	1947	1946
Production	1000 *barrels*	
Crude petroleum..	889,883	847,752
Natural gasoline, etc.	62,938	56,019
Benzole	390	1,170
	953,211	904,941
Imports		
Crude petroleum..	49,077	42,370
Refined products..	33,199	22,978
Exports		
Crude petroleum..	21,125	17,204
Refined products..	60,586	61,125
Domestic Demand ..		
Motor fuel ..	373,155	347,916
Kerosine	52,995	46,308
Distillate fuel oil..	153,820	125,828
Residual fuel oil	257,893	243,067
Lubricating oil ..	17,603	16,168
Wax	1,284	1,103
Asphalt	18,471	17,322
Road oil	2,073	1,454

Preliminary information as to the crude-oil capacity of U.S. refineries at January 1, 1947, is given as:

District	Brl/day
East Coast	811,350
Appalachian	190,985
Illinois, Indiana, etc.	913,870
Oklahoma, Kansas, etc. ..	440,870
Texas, inland	284,675
Texas, Gulf	1,287,600
Louisiana, Gulf..	352,300
Arkansas-Louisiana, inland ..	111,250
New Mexico	12,850
Other Rocky Mountain ..	160,562
California, etc.	1,000,170
Total	5,566,482

JAPANESE INDUSTRIAL STATISTICS

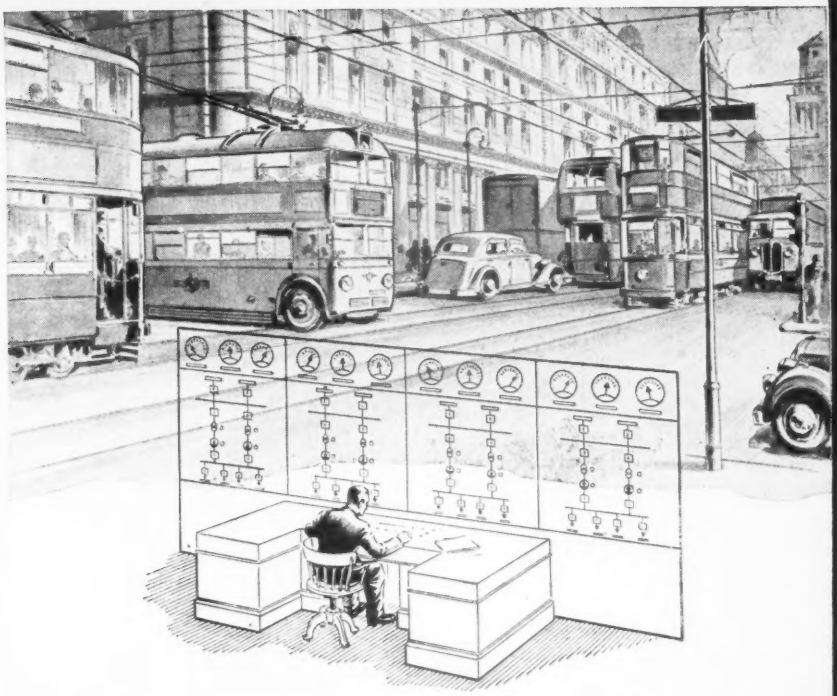
Post-war statistics relating to Japanese industry are becoming available from American sources and H.M.S.O. are publishing extracts under five headings: 1, Forestry and Mining; 2, Heavy Industries; 3, Manufacturing Industries; 4, Textile Industries; 5, Imports and Exports. Issues for January and February, 1947, are now available price 1*s.* 6*d.* to 2*s.* 6*d.* per copy, according to subject.

HARRISON MEMORIAL PRIZE

The Chemical Society announces that the Selection Committee of the Harrison Memorial Fund will consider in December the making of an award of the Harrison Memorial Prize. This prize, not exceeding £150, is awarded to the British chemist, not over 30 years of age, who, during the previous five years, has conducted and published the results of the most meritorious and promising investigations in chemistry. Applications, in quintuplicate and giving the prescribed details, must be received by the President, The Chemical Society, Burlington House, London, W.1., not later than December 1.

BRITISH ELECTRODE CLASSIFICATION

Prepared by the British Electrical and Allied Manufacturers' Association in conjunction with the Institute of Welding, this classification is designed to provide a simple system of applying code numbers to the different makes of British electrodes so that buyers will know which brands are similar. Copies (price 1*s.*), are obtainable from BEAMA, 36-38 Kingsway, London, W.C.2.



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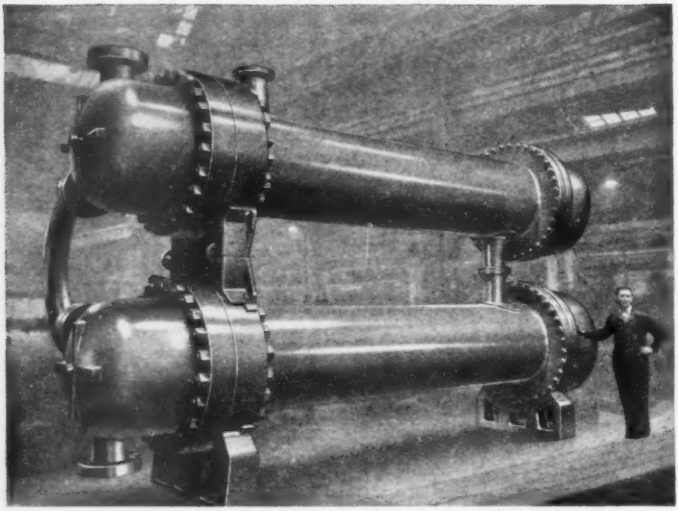

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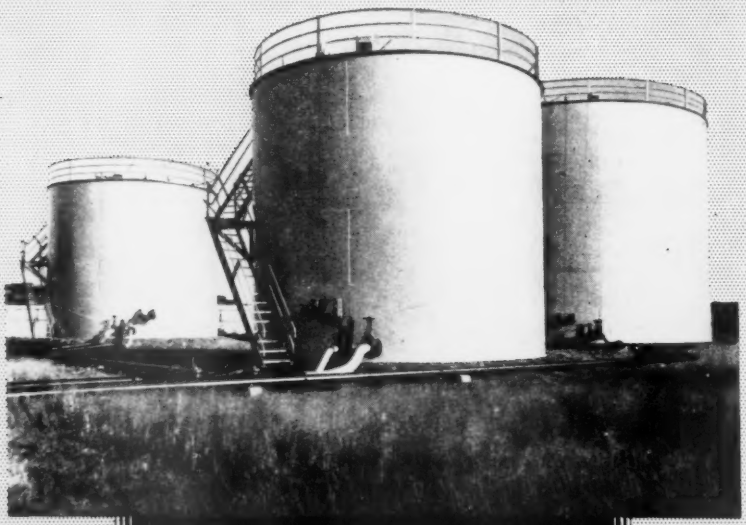

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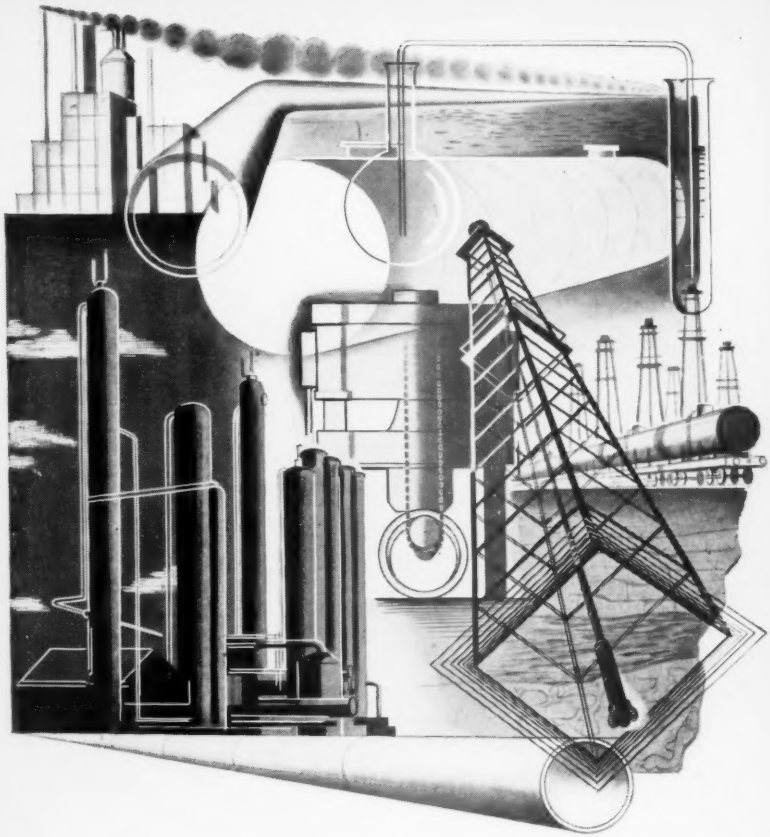

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